

A REVIEW ON SPICES CLASSIFICATION AND RECOGNITION

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ABSTRACT

Spices play a significant role in cooking and consuming food around the world. The main characteristic of Indian cuisine is the use of spices. Spices can make any simple dish flavorful and aromatic and also have several health benefits. According to the International organization for standardization (ISO), there are about 109 spices produced in India. There are many ways in which spices are classified. This paper reviews the classification of spices based on different attributes like family, origin, flavour growth habits etc. and also deep learning methods to identify spices from the image.

KEYWORDS: Classification, Herbs, Spices, Convolutional Neural Network, VGGNet

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1. INTRODUCTION

India is a land of spices and it was mentioned in Vedas one of the ancient Hindu scriptures. The word spice comes from Latin species, meaning a commodity of value and distinction.[1] seed, root, bark or fruit are spices and mainly used for flavouring and garnishing the food. It also contains medical values. India contributes to 75% of global spice production. Kerala is home to a variety of spices. Kerala is the “Spice Capital of India” and “Land of Spices”[2]. The major spices that grow in Kerala are ginger, pepper, clove, Cambodge, turmeric, vanilla, cardamom etc.[3]. In this paper, we review the classification of spices based on different categories.

2. SPICES CLASSIFICATION

India is known as ‘The Home of Spices’. In the area of exporting spices, India has a glorious past. In India, there are around 109 species according to ISO [4]. Hence precise identification of the spices and classification is very important. Spices comprise different plant components. They are

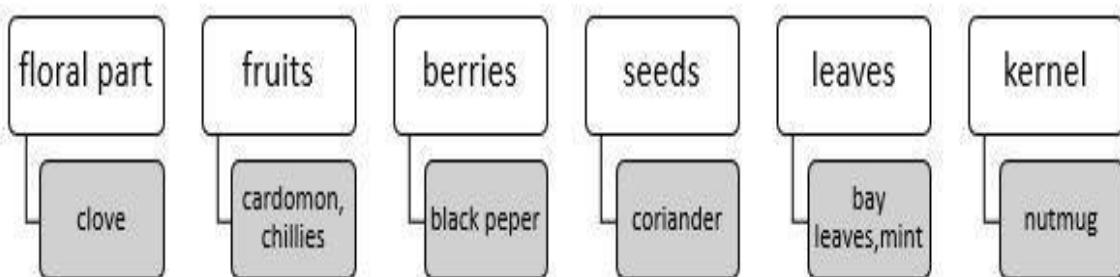


Figure 1: Spices based on Different Parts

The spices are classified in eight ways [5]. They are based on

- Cotyledons
- Family
- Economic importance
- Origin and flavour
- Degree of taste
- Life cycle
- Growth habits
- Parts used

2.1 Based on Cotyledons

The first leaves produced by a plant is known as Cotyledon. It is also defined as “the first leaf or one of the first pair or whorl of leaves developed by the embryo of a seed plant or some lower plants (such as ferns)” [6]. The spices are classified based on cotyledons. The classification is based on the number of cotyledons [7]. They are

- Monocots or monocotyledons: one cotyledon in the seed.
- Dicots or dicotyledonous: two cotyledons in the seed.

The spices are classified based on the cotyledons. They are

- Dicotyledonae: Chilli, red pepper, sesame, pepper, nutmeg, cassia, cinnamon, bay leaf, star anise,
- Monocotyledoneae: Onion, saffron, ginger, turmeric, vanilla, Garlic, cardamom.

2.2 Based on Family

Spices can be classified based on the family means based on their botanical name. There are 22 families of classifications available for spices [8] [9] [10] [11]. They are

Zingiberaceae:	• Large cardamom, small cardamom, ginger, turmeric
Solanaceae:	• Chilli
Piperaceae:	• Pepper, pepper long
Apiaceae:	• Coriander, cumin, celery, garlic, parsley, asafoetida,
Fabaceae:	• Fenugreek
Lauraceae:	• Cinnamon, cassia, tejpat, bay leaf
Rutaceae:	• Curry leaf
Clusiaceae:	• Kokam, camboge.
Lamiaceae:	• Mint, hyssop, marjoram, basil, rosemary, sage
Brassicaceae:	• Mustard, horse radish.
Punicaceae:	• Pomegranate.
Iridaceae:	• Saffron.
Orchidaceae:	• Vanilla.
Liliaceae:	• Star Anise.
Araceae:	• Sweet flag.
Capparidaceae:	• Caper.
Myrtaceae:	• Clove, allspice.
Myristicaceae:	• Nutmeg, mace.
Papaveraceae:	• Poppy seed.
Cupressaceae:	• Juniper berry.
Asteraceae:	• Tarragon.
Caesalpiniaceae:	• Tamarind.

Figure 2: Spices Classification Based on Family.

2.3 Based on Economic Importance

Economic spices are those directly used by man for economic benefit. The spices grown in India can be grouped into two major and minor spices based on the importance of the economy

- Major spices: Spices trade industry in the world is dominated by the major spices. They contribute 75-90% of the total foreign exchange earned through spices.[12][8]. Only five spices come under the category of major spices. they are
 - small cardamom,
 - black pepper,
 - chilli,
 - Turmeric
 - Ginger.
- **Minor spices:** The spices contribute a minor share in the spice trade industry of the world. Excluding all these five major spices, all others are called minor spices. [12]. Minor spices are further divided into five subgroups. They are

Seed spices	Bulbous spices	Aromatic spices	Leafy spices	Acidulant tree spices
•Coriander, cumin, black cumin, fennel, aniseed, celery, mustard, poppy and caraway.	•Garlic, onion, leek and shallot	•Clove, cinnamon, allspice, aniseed and nutmeg	•Curryleaf, mint, rosemary, bayleaf, and parsley.	•Tamarind, kokam and anardana

Figure 3: Spices Classification Based on Minor Spices.

2.4 Based on Origin and Flavour

Flavour means one give a particular taste to food or drink. Based on the characteristics of origin and flavour spices can be classified as four [13] [8] [9]. They are

Aromatic spices:	Pungent spices:	Phenolic spices:	Coloured spices:
• Cardamon, aniseed, clery, cumin, coriander, fenugreek and cinnamon.	• Ginger, chilli, black pepper and mustard	• Clove and allspice	• Turmeric, saffron and paprika

Figure 4: Spices Classification Based on Origin and Flavour.

2.5 Based on the Degree of Taste

Taste can be defined as the sensation experienced through the taste buds. The degree of the taste varies and based on that the spices can be classified as [8][9]

Hot spices:

- Capsicum, black and white peppers, ginger, mustard.

Mild spices:

- Paprika, coriander.

Aromatic spices:

- Allspice, cardamom, cassia, cinnamon, clove, cumin, dill, fennel, fenugreek, mace, nutmeg.

Aromatic vegetables:

- Onion, garlic, celery.

Figure 5: Spices Classification Based on the Degree of Taste.

2.6 Based on the life cycle

The life cycle of a species depends on the season of growth. There are three types of the life cycle for spices [9] [8]. They are

- Annual spices- complete their lifecycle in one season
- Biennial spices- complete their lifecycle in two seasons
- Perennial spices- complete their lifecycle in more than two seasons

Annual spices	Biennial spices:	Perennial spices:
• coriander, cumin, fennel, fenugreek, ajowan and black cumin, aniseed, mustard, chilli.	• onion and parsley.	• Cardamom, turmeric, ginger, black pepper, saffron, clove, nutmeg, asafoetida etc

Figure 6: Spices Classification Based on the Life Cycle

2.7 Based on Growth habits

The growth habits refer to the plant's growth and development. The different types are herbs, shrubs, trees, climbers, creepers. The spices are also classified based on these as follows [8] [9]

Herbs:	Shrubs:	Trees:	Climbers:	Perennial herbs/rhizomatous herbs:
<ul style="list-style-type: none"> Ajowan, coriander, cumin, fenugreek, chillies, parsley 	<ul style="list-style-type: none"> Rosemary, chillies (perennial chillies), pomegranate 	<ul style="list-style-type: none"> Nutmeg, clove, cinnamon, tamarind, garcinia, Japanese pepper 	<ul style="list-style-type: none"> Black pepper, tailed pepper, vanilla 	<ul style="list-style-type: none"> Cardamom, ginger, turmeric, mango ginger.

Figure 7: Spices Classification Based on Growth Habits.

2.8 Based on Parts Used

Depending on the parts of the plant is used we can classify the spices [5] [14] [15] [9]. They are

Seed:	<ul style="list-style-type: none"> Cumin, fenugreek, coriander, poppy
Bulb:	<ul style="list-style-type: none"> Onion, garlic, leek and shallot.
Bark:	<ul style="list-style-type: none"> Cinnamon and cassia
Fruit:	<ul style="list-style-type: none"> Chilli, cardamom, allspice and kokam
Leaf:	<ul style="list-style-type: none"> Mint, curryleaf, bayleaf, chive, rosemary and savory
Rhizome:	<ul style="list-style-type: none"> Turmeric, ginger, and galangal
Pod:	<ul style="list-style-type: none"> Vanilla and tamarind
Kernel:	<ul style="list-style-type: none"> Nutmeg
Floral part:	<ul style="list-style-type: none"> Saffron, savory, caper and marjoram
Bud:	<ul style="list-style-type: none"> Clove and caper
Latex:	<ul style="list-style-type: none"> Asfotida
Aril:	<ul style="list-style-type: none"> Mace and anardana
Berry:	<ul style="list-style-type: none"> Black pepper, juniper and allspice

Figure 8: Spices Classification Based on the Parts Used.

3. COMPARISON

A comparison of the classification of the spices is shown in the graph.

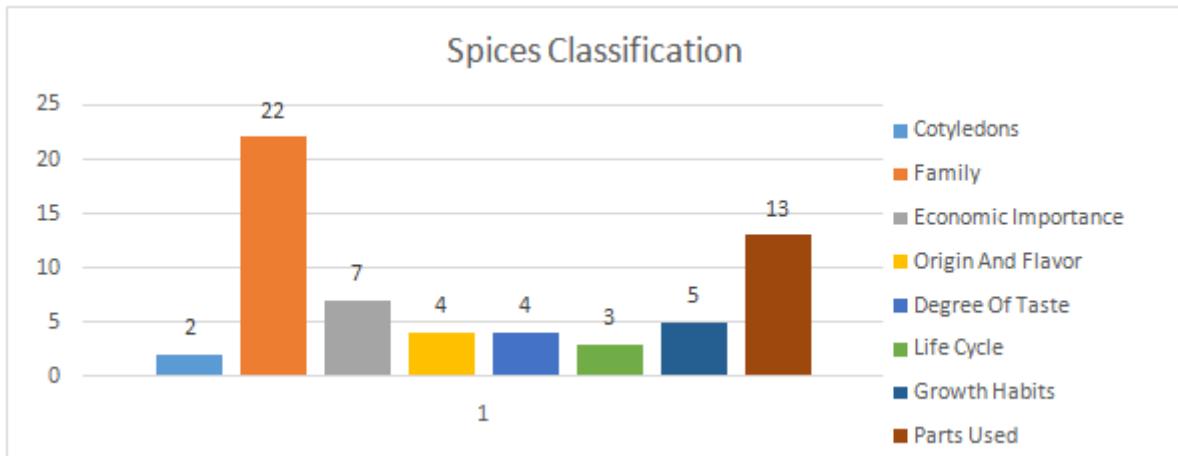


Figure 9: Comparison of Classification Based on the Number of Classes.

The number of classes is high based on the classification based on botanical family and second, highest is based on parts of the seed used. Using a classification either based on origin or flavour is good as the number of classes is less and cover almost all the commonly used spices.

4. SPICES RECOGNITION IN ARTIFICIAL INTELLIGENCE

In recent years the computing of Artificial Intelligence has increased. The term artificial intelligence means the ability to think or learn. A fundamental part of intelligence lies in learning, which leads to the birth of a new concept, known as deep learning. A convolutional neural network method is used to identify and retrieve Chinese herbal medicine images [18]. The architecture consists of a convolution layer which is used filters to capture local information, a pooling layer is used to reduce the sampling and a fully connected layer is used for integrating the local semantic information into global semantic information. The algorithm works in six stages as shown in the figure.

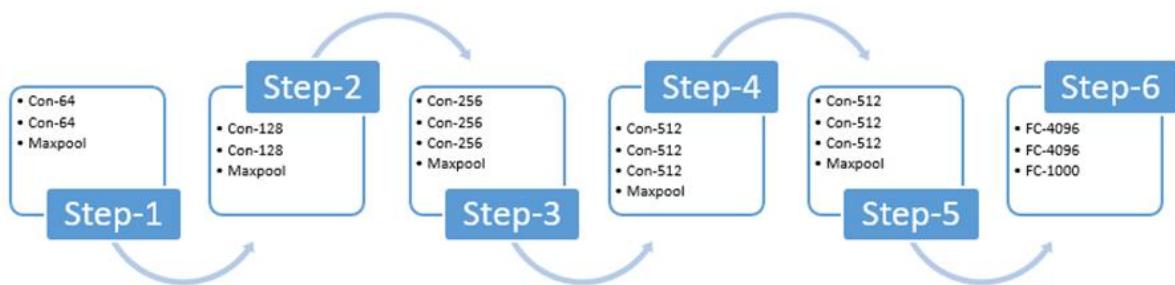


Figure 10: The Architecture of Convolutional Neural Networks.

In step 1 uses two convolution layers and a pooling layer. As steps increase the number of convolution layers gets increased and the last layer consists of three fully connected layers. This architecture provides an accuracy of 75% for the dataset used.

Another method is using a small VGGNet [19]. VGG stands for Visual Geometry Group. The VGG uses block

architecture composed of 2D Convolution and Max Pooling layers. This architecture is used for the identification of Indonesian herbs and spices [20]. The method works based on three steps as shown in the diagram.

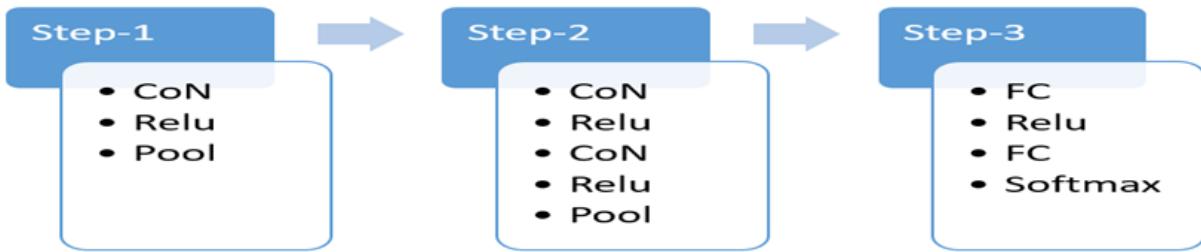


Figure 11: The Architecture of VGGnet.

This method uses a convolution layer followed by the applying Relu activation function and the pooling layer in step1. This process is repeated for steps as the number of convolution layer and pooling layer get increased. In the final step, the fully connected layer is used and contains 27 output units as it classifies the 27 classes of herbs. This method provides an accuracy of average labelling accuracy of 70%

5. CONCLUSIONS

In India, there are around 109 spices and among that, around 40 are commonly used. Classification of these 40 spices based on different criteria is very difficult. The objective of this paper is to give an overview of how the spices are classified based on different criteria. The classification based on family contains 22 categories and based on the parts contains 13 categories. At the same time based on economic importance and cotyledons contains only two categories. Different deep learning methods are available for the identification of spices from the image. Among the different methods, the convolutional neural network works well.

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